

**REMARKS**

Claims 1-60 were originally filed in the present application. Pursuant to a restriction requirement, non-elected claims 56-60 stand withdrawn. No claims are currently canceled or added.

Reconsideration of this application in light of the above amendments and the following remarks is requested.

**Rejections under 35 U.S.C. §102**

**Claim 13**

Claim 13 recites:

13. A method for fabricating a portion of an integrated circuit on a semiconductor substrate, the method comprising:  
placing a pseudo-substrate in a process reactor;  
applying a loading treatment to the pseudo-substrate;  
removing the pseudo-substrate from the process reactor;  
placing a device substrate into the process reactor; and  
forming a poly-silicon layer upon the device substrate.

Claims 13-15 and 19-23 were rejected under 35 U.S.C. §102(b) as being anticipated by U.S. Patent Application Publication No. 2002/0098627 of Pomarede, et al. ("Pomarede").

The PTO provides in MPEP §2131 that

*"[t]o anticipate a claim, the reference must teach every element of the claim...."*

Therefore, to sustain the rejection of claim 13, Pomarede must contain all of the above claimed elements of claim 13. However, while Pomarede discloses processing a device substrate (silicon wafer 16 in Pomarede's FIG. 1) in a process reactor (CVD reactor 10 in Pomarede's FIG. 1), Pomarede fails to additionally disclose placing a pseudo-substrate in the process reactor,

applying a loading treatment to the pseudo-substrate, and removing the pseudo-substrate from the process reactor, among other elements of claim 13. In fact, Pomarede fails to disclose processing any substrate other than the device substrate (silicon wafer 16) in the process reactor (CVD reactor 10).

Therefore, the §102 rejection of claim 13 and its dependent claims 14, 15 and 19-23 is not supported by Pomarede and should be withdrawn.

### **Rejections Under 35 U.S.C. §103: Pomarede**

Claims 16-18 were rejected under 35 U.S.C. §103(a) as being unpatentable over Pomarede. Applicants traverse this rejection on the grounds that Pomarede is defective in establishing a *prima facie* case of obviousness with respect to claim 13 and its dependent claims.

As the PTO recognizes in MPEP §2142:

*... The Examiner bears the initial burden of factually supporting any prima facie conclusion of obviousness. If the Examiner does not produce a prima facie case, the applicant is under no obligation to submit evidence of nonobviousness...*

It is submitted that, in the present case, the Examiner has not factually supported a *prima facie* case of obviousness of claim 13, as described below.

35 U.S.C. §103 provides that:

*A patent may not be obtained ... if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which the subject matter pertains ... (Emphasis added)*

Thus, when evaluating a claim for determining obviousness, all limitations of the claim must be evaluated. However, Pomarede does not teach placing a pseudo-substrate in a process reactor, applying a loading treatment to the pseudo-substrate, and removing the pseudo-substrate

from the process reactor, among other elements of claim 13. Consequently, it is impossible for Pomarede to render obvious the subject matter of claim 13 as a whole, and the explicit terms of the statute cannot be met.

Therefore, the Examiner's burden of factually supporting a *prima facie* case of obviousness cannot be met with respect to claim 13. Accordingly, because claims 16-18 depend from claim 13, the rejection of claims 16-18 under 35 U.S.C. §103 should be withdrawn.

### **Rejections Under 35 U.S.C. §103: Colombo and Ahn**

#### **Claim 42**

Claim 42 recites:

42. A method for fabricating a portion of an integrated circuit on a semiconductor substrate, the method comprising:  
cleaning the surface of the substrate;  
forming a thin insulate on the substrate;  
depositing a high dielectric constant (high-k) material upon the thin insulate;  
performing an anneal on the high-k material;  
applying a hydrogen-containing gas loading treatment upon the annealed high-k material; and  
forming a poly-silicon layer on the treated high-k material, wherein the hydrogen-containing gas loading treatment and poly-silicon deposition occur sequentially.

Claims 42, 51 and 52 were rejected under 35 U.S.C. §103(a) as being unpatentable over U.S. Patent No. 6,809,370 to Colombo, et al. ("Colombo") in view of U.S. Patent Application Publication No. 2002/0192975 of Ahn, et al. ("Ahn"). Applicants traverse this rejection on the grounds that the combination of Colombo and Ahn is defective in establishing a *prima facie* case of obviousness with respect to claim 42 and its dependent claims.

As the PTO recognizes in MPEP §2142:

*... The Examiner bears the initial burden of factually supporting any prima facie conclusion of obviousness. If the Examiner does not produce a prima facie case, the applicant is under no obligation to submit evidence of nonobviousness...*

It is submitted that, in the present case, the Examiner has not factually supported a *prima facie* case of obviousness of claim 42 for the following mutually exclusive reasons.

**1. Even when combined, the references do not teach the claimed subject matter**

As described above, when evaluating a claim for determining obviousness, all limitations of the claim must be evaluated. However, Colombo does not teach the steps of performing an anneal on a high-k material and applying a hydrogen-containing gas loading treatment upon the annealed high-k material, among other elements of claim 42. The Examiner asserts that the plasma nitridation of step 8 in FIG. 1 of Colombo teaches applying a loading treatment upon the high-k material deposited in previous step 6. However, the plasma nitridation of Colombo is not performed on an annealed high-k material, as recited in claim 42.

In addition, Colombo's plasma nitridation does not teach or suggest applying a hydrogen-containing gas loading treatment. That is, Colombo's plasma nitridation is directed towards blocking or inhibiting diffusion of boron from a gate contact layer into an underlying substrate (see column 3, lines 55-59), providing nitrogen concentrations in the bulk high-k dielectric while minimizing the nitrogen concentrations at the dielectric/semiconductor interface (column 4, lines 1-4), preventing phase separation at temperatures less than or equal to 1100 °C (column 4, lines 5-14), improving nitrogen concentration uniformity to decrease temperature-dependent structural phase separation problems and increase device reliability and stability (column 4, lines 19-26). However, Colombo fails to indicate or even suggest that a hydrogen-containing gas treatment can address these same objectives.

Moreover, Ahn fails to cure the shortcomings of Colombo. That is, Ahn also fails to teach or suggest the steps of performing an anneal on a high-k material and applying a hydrogen-containing gas loading treatment upon the annealed high-k material, among other elements of claim 42. Ahn is primarily directed towards means to eliminate the removal of its silicon dioxide layer 30, and fails to mention applying a hydrogen-containing gas loading treatment to any material, annealed or otherwise.

Thus, both Colombo and Ahn fail to teach all limitations of claim 42. Consequently, it is impossible for the combination of Colombo and Ahn to render obvious the subject matter of claim 42 as a whole, and the explicit terms of the statute cannot be met.

Thus, for this mutually exclusive reason, the Examiner's burden of factually supporting a *prima facie* case of obviousness cannot be met with respect to claim 42. Accordingly, because claims 51 and 52 depend from claim 42, the rejection of claims 42, 51 and 52 under 35 U.S.C. §103 should be withdrawn.

**2. Prior art that teaches away from the claimed invention cannot be used to establish obviousness**

In the present case, the Ahn reference, by providing methods for eliminating the cleaning and other silicon dioxide removal steps, is directed to methods which do not include cleaning a substrate surface prior to forming a thin insulate thereon, as recited in claim 42. Thus, Ahn clearly teaches away from claim 42.

Since it is well recognized that teaching away from the claimed invention is a *per se* demonstration of lack of *prima facie* obviousness, it is clear that the Examiner has not borne the initial burden of factually supporting any *prima facie* conclusion of obviousness.

Thus, for this reason alone, the Examiner's burden of factually supporting a *prima facie* case of obviousness cannot be met with respect to claim 42. Accordingly, because claims 51 and 52 depend from claim 42, the rejection of claims 42, 51 and 52 under 35 U.S.C. §103 should be withdrawn.

**3. The combination of references is improper**

Assuming, *arguendo*, that none of the above arguments for non-obviousness apply (which is clearly not the case based on the above), there is still another mutually exclusive and compelling reason why Colombo and Ahn cannot be applied to reject claim 42 and its dependent claims under 35 U.S.C. §103.

§2142 of the MPEP also provides:

*...the Examiner must step backward in time and into the shoes worn by the hypothetical 'person of ordinary skill in the art' when the invention was unknown and just before it was made.....The Examiner must put aside knowledge of the applicant's disclosure, refrain from using hindsight, and consider the subject matter claimed 'as a whole'.*

Here, neither Colombo nor Ahn teaches, or even suggests, the desirability of the combination since neither teaches the steps of performing an anneal on a high-k material and applying a hydrogen-containing gas loading treatment upon the annealed high-k material, among other elements of claim 42.

Thus, it is clear that neither Colombo nor Ahn provides any incentive or motivation supporting the desirability of the combination. Therefore, there is simply no basis in the art for combining the references to support a 35 U.S.C. §103 rejection.

In this context, the MPEP further provides at §2143.01:

*The mere fact that references can be combined or modified does not render the resultant combination obvious unless the prior art also suggests the desirability of the combination.*

In the above context, the courts have repeatedly held that obviousness cannot be established by combining the teachings of the prior art to produce the claimed invention, absent some teaching, suggestion or incentive supporting the combination.

In the present case, it is clear that the Examiner's combination arises solely from hindsight based on the invention, since there is no showing, suggestion, incentive or motivation in either reference for the combination as applied to claim 42. Thus, for this reason alone, the Examiner's burden of factually supporting a *prima facie* case of obviousness cannot be met with respect to claim 42. Accordingly, because claims 51 and 52 depend from claim 42, the rejection of claims 42, 51 and 52 under 35 U.S.C. §103 should be withdrawn.

**Rejections Under 35 U.S.C. §103: Colombo, Ahn and Pomarede**

Claims 43-50, 53 and 54 were rejected under 35 U.S.C. §103(a) as being unpatentable over Colombo in view of Ahn and further in view of Pomarede. Applicants traverse this rejection on the grounds that the combination of Colombo, Ahn and Pomarede is defective in establishing a *prima facie* case of obviousness with respect to claim 42 and its dependent claims, for the following mutually exclusive reasons.

**1. Even when combined, the references do not teach the claimed subject matter**

As described above, when evaluating a claim for determining obviousness, all limitations of the claim must be evaluated. However, as also described above, neither Colombo nor Ahn teaches the steps of performing an anneal on a high-k material and applying a hydrogen-containing gas loading treatment upon the annealed high-k material, among other elements of claim 42. Moreover, Pomarede fails to cure these shortcomings.

That is, Pomarede also fails to teach or suggest the steps of performing an anneal on a high-k material and applying a hydrogen-containing gas loading treatment upon the annealed high-k material, among other elements of claim 42. In contrast, Pomarede merely discloses treatment of an un-annealed gate dielectric with excited chlorine or fluorine radicals, and fails to teach performing an anneal step until after the poly-SiGe gate electrode is deposited over the un-annealed gate dielectric.

Thus, each of Colombo, Ahn and Pomarede fail to teach all limitations of claim 42. Consequently, it is impossible for the combination of Colombo, Ahn and Pomarede to render obvious the subject matter of claim 42 as a whole, and the explicit terms of the statute cannot be met.

Thus, for this mutually exclusive reason, the Examiner's burden of factually supporting a *prima facie* case of obviousness cannot be met with respect to claim 42. Accordingly, because claims 43-50, 53 and 54 depend from claim 42, the rejection of claims 43-50, 53 and 54 under 35 U.S.C. §103 should be withdrawn.

**2. Prior art that teaches away from the claimed invention cannot be used to establish obviousness**

In the present case, the Ahn reference, by providing methods for eliminating the cleaning and other silicon dioxide removal steps, is directed to methods which do not include cleaning a substrate surface prior to forming a thin insulate thereon, as recited in claim 42. Thus, Ahn clearly teaches away from claim 42.

Since it is well recognized that teaching away from the claimed invention is a *per se* demonstration of lack of *prima facie* obviousness, it is clear that the Examiner has not borne the initial burden of factually supporting any *prima facie* conclusion of obviousness.

Thus, for this reason alone, the Examiner's burden of factually supporting a *prima facie* case of obviousness cannot be met with respect to claim 42. Accordingly, because claims 43-50, 53 and 54 depend from claim 42, the rejection of claims 43-50, 53 and 54 under 35 U.S.C. §103 should be withdrawn.

**3. The combination of references is improper**

Assuming, arguendo, that none of the above arguments for non-obviousness apply (which is clearly not the case based on the above), there is still another mutually exclusive and compelling reason why Colombo, Ahn and Pomarede cannot be applied to reject any claims depending from claim 42 under 35 U.S.C. §103. That is, neither Colombo, Ahn nor Pomarede teaches, or even suggests, the desirability of the combination since none of the references teach the steps of performing an anneal on a high-k material and applying a hydrogen-containing gas loading treatment upon the annealed high-k material, among other elements of claim 42.

Thus, it is clear that neither Colombo, Ahn nor Pomarede provides any incentive or motivation supporting the desirability of the combination. Therefore, there is simply no basis in the art for combining the references to support a 35 U.S.C. §103 rejection.



In this context, the courts have repeatedly held that obviousness cannot be established by combining the teachings of the prior art to produce the claimed invention, absent some teaching, suggestion or incentive supporting the combination. In the present case, it is clear that the Examiner's combination arises solely from hindsight based on the invention, since there is no showing, suggestion, incentive or motivation in either reference for the combination as applied to claim 42 or its dependent claims. Thus, for this reason alone, the Examiner's burden of factually supporting a *prima facie* case of obviousness cannot be met with respect to claim 42. Accordingly, because claims 43-50, 53 and 54 depend from claim 42, the rejection of claims 43-50, 53 and 54 under 35 U.S.C. §103 should be withdrawn.

**Rejections Under 35 U.S.C. §103: Colombo, Ahn and Rayssac**

Claim 55 was rejected under 35 U.S.C. §103(a) as being unpatentable over Colombo in view of Ahn and further in view of U.S. Patent Application Publication No. 2004/0178448 of Rayssac, et al. ("Rayssac"). Applicants traverse this rejection on the grounds that the combination of Colombo, Ahn and Rayssac is defective in establishing a *prima facie* case of obviousness with respect to claim 42 and its dependent claims, for the following mutually exclusive reasons.

**1. Even when combined, the references do not teach the claimed subject matter**

As described above, when evaluating a claim for determining obviousness, all limitations of the claim must be evaluated. However, as also described above, neither Colombo nor Ahn teaches the steps of performing an anneal on a high-k material and applying a hydrogen-containing gas loading treatment upon the annealed high-k material, among other elements of claim 42. Moreover, Rayssac fails to cure these shortcomings.

That is, Rayssac also fails to teach or suggest the steps of performing an anneal on a high-k material and applying a hydrogen-containing gas loading treatment upon the annealed high-k material, among other elements of claim 42. In fact, Rayssac fails to disclose any such treatment or any annealing process, and is instead merely directed towards a semiconductor structure that

includes a substrate made of a material that provides atypical surface properties, a bonding layer on the substrate surface, and a further layer molecularly bonded to the bonding layer, where the atypical surface properties can include a roughness of more than 0.5 nm rms, or a roughness of at least 0.4 nm rms that is difficult to polish, or a chemical composition that is incompatible with molecular bonding.

Thus, each of Colombo, Ahn and Rayssac fail to teach all limitations of claim 42. Consequently, it is impossible for the combination of Colombo, Ahn and Rayssac to render obvious the subject matter of claim 42 as a whole, and the explicit terms of the statute cannot be met.

Thus, for this mutually exclusive reason, the Examiner's burden of factually supporting a *prima facie* case of obviousness cannot be met with respect to claim 42. Accordingly, because claim 55 depends from claim 42, the rejection of claim 55 under 35 U.S.C. §103 should be withdrawn.

**2. Prior art that teaches away from the claimed invention cannot be used to establish obviousness**

In the present case, the Ahn reference, by providing methods for eliminating the cleaning and other silicon dioxide removal steps, is directed to methods which do not include cleaning a substrate surface prior to forming a thin insulate thereon, as recited in claim 42. Thus, Ahn clearly teaches away from claim 42.

Since it is well recognized that teaching away from the claimed invention is a *per se* demonstration of lack of *prima facie* obviousness, it is clear that the Examiner has not borne the initial burden of factually supporting any *prima facie* conclusion of obviousness.

Thus, for this reason alone, the Examiner's burden of factually supporting a *prima facie* case of obviousness cannot be met with respect to claim 42. Accordingly, because claim 55 depends from claim 42, the rejection of claim 55 under 35 U.S.C. §103 should be withdrawn.

### **3. The combination of references is improper**

Assuming, *arguendo*, that none of the above arguments for non-obviousness apply (which is clearly not the case based on the above), there is still another mutually exclusive and compelling reason why Colombo, Ahn and Rayssac cannot be applied to reject any claims depending from claim 42 under 35 U.S.C. §103. That is, neither Colombo, Ahn nor Rayssac teaches, or even suggests, the desirability of the combination since none of the references teach the steps of performing an anneal on a high-k material and applying a hydrogen-containing gas loading treatment upon the annealed high-k material, among other elements of claim 42.

Thus, it is clear that neither Colombo, Ahn nor Rayssac provides any incentive or motivation supporting the desirability of the combination. Therefore, there is simply no basis in the art for combining the references to support a 35 U.S.C. §103 rejection.

In this context, the courts have repeatedly held that obviousness cannot be established by combining the teachings of the prior art to produce the claimed invention, absent some teaching, suggestion or incentive supporting the combination. In the present case, it is clear that the Examiner's combination arises solely from hindsight based on the invention, since there is no showing, suggestion, incentive or motivation in either reference for the combination as applied to claim 42 or its dependent claims. Thus, for this reason alone, the Examiner's burden of factually supporting a *prima facie* case of obviousness cannot be met with respect to claim 42. Accordingly, because claim 55 depends from claim 42, the rejection of claim 55 under 35 U.S.C. §103 should be withdrawn.

### **Rejections Under 35 U.S.C. §103: Colombo, Ahn, Rotonadaro '826 and Rotonadaro '121**

Claims 1, 9, 24 and 35 were rejected under 35 U.S.C. §103(a) as being unpatentable over Colombo in view of Ahn, U.S. Patent Application Publication No. 2002/0081826 of Rotonadaro, et al. ("Rotonadaro '826"), and U.S. Patent Application Publication No. 2005/0124121 of Rotonadaro, et al. ("Rotonadaro '121"). Applicants traverse this rejection on the grounds that the combination of Colombo, Ahn, Rotonadaro '826 and Rotonadaro '121 is defective in establishing a *prima facie* case of obviousness for the following mutually exclusive reasons.

Claim 1

Claim 1 recites:

1. A method for fabricating a portion of an integrated circuit on a semiconductor substrate, the method comprising:  
cleaning the surface of the substrate;  
forming a thin insulate over the substrate;  
depositing a high dielectric constant (high-k) material over the thin insulate;  
performing a hydrogen-based anneal on the high-k material;  
and  
performing an oxygen-based anneal on the high-k material, wherein the hydrogen-based and oxygen-based anneals occur sequentially.

Applicants traverse the §103 rejection of claims 1 and 9 on the grounds that the combination of Colombo, Ahn, Rotonadaro '826 and Rotonadaro '121 is defective in establishing a *prima facie* case of obviousness with respect to claim 1 and its dependent claims, for the following mutually exclusive reasons.

**1. Even when combined, the references do not teach the claimed subject matter**

As described above, when evaluating a claim for determining obviousness, all limitations of the claim must be evaluated. However, none of the cited references teach the steps of performing a hydrogen-based anneal and an oxygen-based anneal on a high-k material, wherein the hydrogen-based and oxygen-based anneals occur sequentially, among other elements of claim 1. In fact, none of the references teach performing both a hydrogen-based anneal and an oxygen-based anneal on a high-k material, whether sequentially or otherwise.

For example, the Examiner concedes that Colombo fails to teach performing a hydrogen-based anneal on a high-k material. (Examiner's Office Action, page 8). Further, Ahn fails to teach performing any annealing process on a high-k material, and instead merely mentions that a substrate can be pre-cleaned to minimize surface oxide with an HF clean and/or hydrogen anneal step. (Paragraph [0024]).

Moreover, both Rotonadaro '826 and Rotonadaro '121 teach employing an "H<sub>2</sub> + O<sub>2</sub>" annealing ambient ("wet oxidation") to achieve a relative increase in the advantages of annealing (proper oxidation, purification, and densification) as compared to the disadvantage of annealing (the growth of lower-k dielectrics). However, the Rotonadaro references each teach performing a single annealing step utilizing an annealing ambient comprising hydrogen *and* oxygen, but fail to teach performing a hydrogen-based annealing step and an oxygen-based annealing step.

Thus, each of Colombo, Ahn, Rotonadaro '826 and Rotonadaro '121 fail to teach all limitations of claim 1. Consequently, it is impossible for the combination of Colombo, Ahn, Rotonadaro '826 and Rotonadaro '121 to render obvious the subject matter of claim 1 as a whole, and the explicit terms of the statute cannot be met.

Thus, for this mutually exclusive reason, the Examiner's burden of factually supporting a *prima facie* case of obviousness cannot be met with respect to claim 1. Accordingly, the rejection of claim 1 under 35 U.S.C. §103 should be withdrawn. Moreover, because claim 9 depends from claim 1, the rejection of claim 9 under 35 U.S.C. §103 should also be withdrawn.

**2. Prior art that teaches away from the claimed invention cannot be used to establish obviousness**

In the present case, the Ahn reference, by providing methods for eliminating the cleaning and other silicon dioxide removal steps, is directed to methods which do not include cleaning a substrate surface prior to forming a thin insulate thereon, as recited in claim 1. Thus, Ahn clearly teaches away from claim 1.

Additionally, the Rotonadaro references each teach that rapid thermal processing ("RTP") has been used for gate dielectric layer densification using an inert ambient gas, but the use of such an inert ambient does not properly oxidize the annealed material. The Rotonadaro references also teach that, alternatively, RTP has been used to oxidize materials and to remove impurities from the materials using an oxygen ambient gas, but the use of an oxygen ambient may promote the growth of silicon dioxide or other "lower-k" dielectrics at the interface of the gate dielectric layer and the substrate, where silicon dioxide or other lower-k dielectrics reduce

the effective capacitance and increase the equivalent oxide-thickness of high-k gate dielectric layers since the effective dielectric constant of the gate dielectric layer is reduced due to the introduction of a lower-k material between the gate dielectric layer and substrate. Thus, the Rotonadaro references are directed to methods which do not include annealing with either an inert ambient gas or an oxygen ambient gas, in direct contrast to the hydrogen-based and oxygen-based annealing steps recited in claim 1. Consequently, the Rotonadaro references each clearly teach away from claim 1.

Since it is well recognized that teaching away from the claimed invention is a *per se* demonstration of lack of *prima facie* obviousness, it is clear that the Examiner has not borne the initial burden of factually supporting any *prima facie* conclusion of obviousness.

Thus, for this reason alone, the Examiner's burden of factually supporting a *prima facie* case of obviousness cannot be met with respect to claim 1. Accordingly, the rejection of claim 1 under 35 U.S.C. §103 should be withdrawn. Moreover, because claim 9 depends from claim 1, the rejection of claim 9 under 35 U.S.C. §103 should also be withdrawn.

### **3. The combination of references is improper**

Assuming, arguendo, that none of the above arguments for non-obviousness apply (which is clearly not the case based on the above), there is still another mutually exclusive and compelling reason why Colombo, Ahn, Rotonadaro '826 and Rotonadaro '121 cannot be applied to reject claim 1 under 35 U.S.C. §103. That is, neither Colombo, Ahn, Rotonadaro '826 nor Rotonadaro '121 teaches, or even suggests, the desirability of the combination since none of the references teach the steps of performing a hydrogen-based anneal and an oxygen-based anneal on a high-k material, wherein the hydrogen-based and oxygen-based anneals occur sequentially, among other elements of claim 1.

Thus, it is clear that neither Colombo, Ahn, Rotonadaro '826 nor Rotonadaro '121 provides any incentive or motivation supporting the desirability of the combination. Therefore, there is simply no basis in the art for combining the references to support a 35 U.S.C. §103 rejection.

In this context, the courts have repeatedly held that obviousness cannot be established by combining the teachings of the prior art to produce the claimed invention, absent some teaching, suggestion or incentive supporting the combination. In the present case, it is clear that the Examiner's combination arises solely from hindsight based on the invention, since there is no showing, suggestion, incentive or motivation in either reference for the combination as applied to claim 1. Thus, for this reason alone, the Examiner's burden of factually supporting a *prima facie* case of obviousness cannot be met with respect to claim 1. Accordingly, the rejection of claim 1 under 35 U.S.C. §103 should be withdrawn. Moreover, because claim 9 depends from claim 1, the rejection of claim 9 under 35 U.S.C. §103 should also be withdrawn.

Claim 24

Claim 24 recites:

24. A method for fabricating a portion of an integrated circuit on a semiconductor substrate, the method comprising:  
cleaning the surface of the substrate;  
forming a thin insulate over the substrate;  
depositing a high dielectric constant (high-k) material over the thin insulate;  
performing a hydrogen-based anneal on the high-k material;  
performing an oxygen-based anneal on the high-k material, wherein the hydrogen-based and oxygen-based anneals occur sequentially;  
applying a loading treatment to the high-k material; and  
forming a poly-silicon layer on the treated high-k material, wherein the loading treatment and poly-silicon deposition occur sequentially.

Applicants traverse the §103 rejection of claims 24 and 35 on the grounds that the combination of Colombo, Ahn, Rotonadaro '826 and Rotonadaro '121 is defective in establishing a *prima facie* case of obviousness with respect to claim 24 and its dependent claims, for the following mutually exclusive reasons.

**1. Even when combined, the references do not teach the claimed subject matter**

As described above, when evaluating a claim for determining obviousness, all limitations of the claim must be evaluated. However, none of the cited references teach the steps of performing a hydrogen-based anneal and an oxygen-based anneal on a high-k material, wherein the hydrogen-based and oxygen-based anneals occur sequentially, among other elements of claim 24. In fact, none of the references teach performing both a hydrogen-based anneal and an oxygen-based anneal on a high-k material, whether sequentially or otherwise.

For example, the Examiner concedes that Colombo fails to teach performing a hydrogen-based anneal on a high-k material. (Examiner's Office Action, page 8). Further, Ahn fails to teach performing any annealing process on a high-k material, and instead merely mentions that a substrate can be pre-cleaned to minimize surface oxide with an HF clean and/or hydrogen anneal step. (Paragraph [0024]).

Moreover, both Rotonadaro '826 and Rotonadaro '121 teach employing an " $H_2 + O_2$ " annealing ambient ("wet oxidation") to achieve a relative increase in the advantages of annealing (proper oxidation, purification, and densification) as compared to the disadvantage of annealing (the growth of lower-k dielectrics). However, the Rotonadaro references each teach performing a single annealing step utilizing an annealing ambient comprising hydrogen *and* oxygen, but fail to teach performing a hydrogen-based annealing step and an oxygen-based annealing step.

Thus, each of Colombo, Ahn, Rotonadaro '826 and Rotonadaro '121 fail to teach all limitations of claim 24. Consequently, it is impossible for the combination of Colombo, Ahn, Rotonadaro '826 and Rotonadaro '121 to render obvious the subject matter of claim 24 as a whole, and the explicit terms of the statute cannot be met.

Thus, for this mutually exclusive reason, the Examiner's burden of factually supporting a *prima facie* case of obviousness cannot be met with respect to claim 24. Accordingly, the rejection of claim 24 under 35 U.S.C. §103 should be withdrawn. Moreover, because claim 35 depends from claim 24, the rejection of claim 35 under 35 U.S.C. §103 should also be withdrawn.



**2. Prior art that teaches away from the claimed invention cannot be used to establish obviousness**

In the present case, the Ahn reference, by providing methods for eliminating the cleaning and other silicon dioxide removal steps, is directed to methods which do not include cleaning a substrate surface prior to forming a thin insulate thereon, as recited in claim 24. Thus, Ahn clearly teaches away from claim 24.

Additionally, the Rotonadaro references each teach that rapid thermal processing (“RTP”) has been used for gate dielectric layer densification using an inert ambient gas, but the use of such an inert ambient does not properly oxidize the annealed material. The Rotonadaro references also teach that, alternatively, RTP has been used to oxidize materials and to remove impurities from the materials using an oxygen ambient gas, but the use of an oxygen ambient may promote the growth of silicon dioxide or other “lower-k” dielectrics at the interface of the gate dielectric layer and the substrate, where silicon dioxide or other lower-k dielectrics reduce the effective capacitance and increase the equivalent oxide-thickness of high-k gate dielectric layers since the effective dielectric constant of the gate dielectric layer is reduced due to the introduction of a lower-k material between the gate dielectric layer and substrate. Thus, the Rotonadaro references are directed to methods which do not include annealing with either an inert ambient gas or an oxygen ambient gas, in direct contrast to the hydrogen-based and oxygen-based annealing steps recited in claim 24. Consequently, the Rotonadaro references each clearly teach away from claim 24.

Since it is well recognized that teaching away from the claimed invention is a *per se* demonstration of lack of *prima facie* obviousness, it is clear that the Examiner has not borne the initial burden of factually supporting any *prima facie* conclusion of obviousness.

Thus, for this reason alone, the Examiner’s burden of factually supporting a *prima facie* case of obviousness cannot be met with respect to claim 24. Accordingly, the rejection of claim 24 under 35 U.S.C. §103 should be withdrawn. Moreover, because claim 35 depends from claim 24, the rejection of claim 35 under 35 U.S.C. §103 should also be withdrawn.

**3. The combination of references is improper**

Assuming, *arguendo*, that none of the above arguments for non-obviousness apply (which is clearly not the case based on the above), there is still another mutually exclusive and compelling reason why Colombo, Ahn, Rotonadaro '826 and Rotonadaro '121 cannot be applied to reject claim 24 under 35 U.S.C. §103. That is, neither Colombo, Ahn, Rotonadaro '826 nor Rotonadaro '121 teaches, or even suggests, the desirability of the combination since none of the references teach the steps of performing a hydrogen-based anneal and an oxygen-based anneal on a high-k material, wherein the hydrogen-based and oxygen-based anneals occur sequentially, among other elements of claim 24.

Thus, it is clear that neither Colombo, Ahn, Rotonadaro '826 nor Rotonadaro '121 provides any incentive or motivation supporting the desirability of the combination. Therefore, there is simply no basis in the art for combining the references to support a 35 U.S.C. §103 rejection.

In this context, the courts have repeatedly held that obviousness cannot be established by combining the teachings of the prior art to produce the claimed invention, absent some teaching, suggestion or incentive supporting the combination. In the present case, it is clear that the Examiner's combination arises solely from hindsight based on the invention, since there is no showing, suggestion, incentive or motivation in either reference for the combination as applied to claim 24. Thus, for this reason alone, the Examiner's burden of factually supporting a *prima facie* case of obviousness cannot be met with respect to claim 24. Accordingly, the rejection of claim 24 under 35 U.S.C. §103 should be withdrawn. Moreover, because claim 35 depends from claim 24, the rejection of claim 35 under 35 U.S.C. §103 should also be withdrawn.

**Rejections Under 35 U.S.C. §103: Colombo, Ahn, Rotonadaro '826, Rotonadaro '121 and Pomarede**

Claims 2-8, 10, 11, 25-34 and 36-40 were rejected under 35 U.S.C. §103(a) as being unpatentable over Colombo in view of Ahn, Rotonadaro '826, Rotonadaro '121 and Pomarede. Applicants traverse this rejection on the grounds that the combination of Colombo, Ahn, Rotonadaro '826, Rotonadaro '121 and Pomarede is defective in establishing a *prima facie* case of obviousness for the following mutually exclusive reasons.

**Claim 1**

Applicants traverse the §103 rejection of claims 2-8, 10 and 11 on the grounds that the combination of Colombo, Ahn, Rotonadaro '826, Rotonadaro '121 and Pomarede is defective in establishing a *prima facie* case of obviousness with respect to claim 1 and its dependent claims, for the following mutually exclusive reasons.

**1. Even when combined, the references do not teach the claimed subject matter**

As described above, when evaluating a claim for determining obviousness, all limitations of the claim must be evaluated. However, none of the cited references teach the steps of performing a hydrogen-based anneal and an oxygen-based anneal on a high-k material, wherein the hydrogen-based and oxygen-based anneals occur sequentially, among other elements of claim 1. In fact, none of the references teach performing both a hydrogen-based anneal and an oxygen-based anneal on a high-k material, whether sequentially or otherwise.

For example, the Examiner concedes that Colombo fails to teach performing a hydrogen-based anneal on a high-k material. (Examiner's Office Action, page 8). Further, Ahn fails to teach performing any annealing process on a high-k material, and instead merely mentions that a substrate can be pre-cleaned to minimize surface oxide with an HF clean and/or hydrogen anneal step. (Paragraph [0024]).

Moreover, both Rotonadaro '826 and Rotonadaro '121 teach employing an "H<sub>2</sub> + O<sub>2</sub>" annealing ambient ("wet oxidation") to achieve a relative increase in the advantages of annealing (proper oxidation, purification, and densification) as compared to the disadvantage of annealing (the growth of lower-k dielectrics). However, the Rotonadaro references each teach performing a single annealing step utilizing an annealing ambient comprising hydrogen *and* oxygen, but fail to teach performing a hydrogen-based annealing step and an oxygen-based annealing step.

Additionally, Pomarede fails to teach performing any annealing step on a high-k material, whatsoever. Consequently, Pomarede necessarily fails to teach performing both a hydrogen-based anneal and an oxygen-based anneal.

Thus, each of Colombo, Ahn, Rotonadaro '826, Rotonadaro '121 and Pomarede fail to teach all limitations of claim 1. Consequently, it is impossible for the combination of Colombo, Ahn, Rotonadaro '826, Rotonadaro '121 and Pomarede to render obvious the subject matter of claim 1 as a whole, and the explicit terms of the statute cannot be met.

Thus, for this mutually exclusive reason, the Examiner's burden of factually supporting a *prima facie* case of obviousness cannot be met with respect to claim 1. Accordingly, because claims 2-8, 10 and 11 depend from claim 1, the rejection of claims 2-8, 10 and 11 under 35 U.S.C. §103 should be withdrawn.

**2. Prior art that teaches away from the claimed invention cannot be used to establish obviousness**

In the present case, the Ahn reference, by providing methods for eliminating the cleaning and other silicon dioxide removal steps, is directed to methods which do not include cleaning a substrate surface prior to forming a thin insulate thereon, as recited in claim 1. Thus, Ahn clearly teaches away from claim 1.

Additionally, the Rotonadaro references each teach that rapid thermal processing ("RTP") has been used for gate dielectric layer densification using an inert ambient gas, but the use of such an inert ambient does not properly oxidize the annealed material. The Rotonadaro references also teach that, alternatively, RTP has been used to oxidize materials and to remove

impurities from the materials using an oxygen ambient gas, but the use of an oxygen ambient may promote the growth of silicon dioxide or other “lower-k” dielectrics at the interface of the gate dielectric layer and the substrate, where silicon dioxide or other lower-k dielectrics reduce the effective capacitance and increase the equivalent oxide-thickness of high-k gate dielectric layers since the effective dielectric constant of the gate dielectric layer is reduced due to the introduction of a lower-k material between the gate dielectric layer and substrate. Thus, the Rotonadaro references are directed to methods which do not include annealing with either an inert ambient gas or an oxygen ambient gas, in direct contrast to the hydrogen-based and oxygen-based annealing steps recited in claim 1. Consequently, the Rotonadaro references each clearly teach away from claim 1.

Since it is well recognized that teaching away from the claimed invention is a *per se* demonstration of lack of *prima facie* obviousness, it is clear that the Examiner has not borne the initial burden of factually supporting any *prima facie* conclusion of obviousness.

Thus, for this reason alone, the Examiner’s burden of factually supporting a *prima facie* case of obviousness cannot be met with respect to claim 1. Accordingly, because claims 2-8, 10 and 11 depend from claim 1, the rejection of claims 2-8, 10 and 11 under 35 U.S.C. §103 should be withdrawn.

### **3. The combination of references is improper**

Assuming, *arguendo*, that none of the above arguments for non-obviousness apply (which is clearly not the case based on the above), there is still another mutually exclusive and compelling reason why Colombo, Ahn, Rotonadaro '826, Rotonadaro '121 and Pomarede cannot be applied to reject claims depending from claim 1 under 35 U.S.C. §103. That is, neither Colombo, Ahn, Rotonadaro '826, Rotonadaro '121 nor Pomarede teaches, or even suggests, the desirability of the combination since none of the references teach the steps of performing a hydrogen-based anneal and an oxygen-based anneal on a high-k material, wherein the hydrogen-based and oxygen-based anneals occur sequentially, among other elements of claim 1.

Thus, it is clear that neither Colombo, Ahn, Rotonadaro '826, Rotonadaro '121 nor Pomarede provides any incentive or motivation supporting the desirability of the combination. Therefore, there is simply no basis in the art for combining the references to support a 35 U.S.C. §103 rejection.

In this context, the courts have repeatedly held that obviousness cannot be established by combining the teachings of the prior art to produce the claimed invention, absent some teaching, suggestion or incentive supporting the combination. In the present case, it is clear that the Examiner's combination arises solely from hindsight based on the invention, since there is no showing, suggestion, incentive or motivation in either reference for the combination as applied to claim 1. Thus, for this reason alone, the Examiner's burden of factually supporting a *prima facie* case of obviousness cannot be met with respect to claim 1. Accordingly, because claims 2-8, 10 and 11 depend from claim 1, the rejection of claims 2-8, 10 and 11 under 35 U.S.C. §103 should be withdrawn.

#### Claim 24

Applicants traverse the §103 rejection of claims 25-34 and 36-40 on the grounds that the combination of Colombo, Ahn, Rotonadaro '826, Rotonadaro '121 and Pomarede is defective in establishing a *prima facie* case of obviousness with respect to claim 24 and its dependent claims, for the following mutually exclusive reasons.

**1. Even when combined, the references do not teach the claimed subject matter**

As described above, when evaluating a claim for determining obviousness, all limitations of the claim must be evaluated. However, none of the cited references teach the steps of performing a hydrogen-based anneal and an oxygen-based anneal on a high-k material, wherein the hydrogen-based and oxygen-based anneals occur sequentially, among other elements of claim 24. In fact, none of the references teach performing both a hydrogen-based anneal and an oxygen-based anneal on a high-k material, whether sequentially or otherwise.

For example, the Examiner concedes that Colombo fails to teach performing a hydrogen-based anneal on a high-k material. (Examiner's Office Action, page 8). Further, Ahn fails to teach performing any annealing process on a high-k material, and instead merely mentions that a substrate can be pre-cleaned to minimize surface oxide with an HF clean and/or hydrogen anneal step. (Paragraph [0024]).

Moreover, both Rotonadaro '826 and Rotonadaro '121 teach employing an " $H_2 + O_2$ " annealing ambient ("wet oxidation") to achieve a relative increase in the advantages of annealing (proper oxidation, purification, and densification) as compared to the disadvantage of annealing (the growth of lower-k dielectrics). However, the Rotonadaro references each teach performing a single annealing step utilizing an annealing ambient comprising hydrogen *and* oxygen, but fail to teach performing a hydrogen-based annealing step and an oxygen-based annealing step.

Additionally, Pomarede fails to teach performing any annealing step on a high-k material, whatsoever. Consequently, Pomarede necessarily fails to teach performing both a hydrogen-based anneal and an oxygen-based anneal.

Thus, each of Colombo, Ahn, Rotonadaro '826, Rotonadaro '121 and Pomarede fail to teach all limitations of claim 24. Consequently, it is impossible for the combination of Colombo, Ahn, Rotonadaro '826, Rotonadaro '121 and Pomarede to render obvious the subject matter of claim 24 as a whole, and the explicit terms of the statute cannot be met.

Thus, for this mutually exclusive reason, the Examiner's burden of factually supporting a *prima facie* case of obviousness cannot be met with respect to claim 24. Accordingly, because claims 25-34 and 36-40 depend from claim 24, the rejection of claims 25-34 and 36-40 under 35 U.S.C. §103 should be withdrawn.

**2. Prior art that teaches away from the claimed invention cannot be used to establish obviousness**

In the present case, the Ahn reference, by providing methods for eliminating the cleaning and other silicon dioxide removal steps, is directed to methods which do not include cleaning a substrate surface prior to forming a thin insulate thereon, as recited in claim 24. Thus, Ahn clearly teaches away from claim 24.

Additionally, the Rotonadaro references each teach that rapid thermal processing ("RTP") has been used for gate dielectric layer densification using an inert ambient gas, but the use of such an inert ambient does not properly oxidize the annealed material. The Rotonadaro references also teach that, alternatively, RTP has been used to oxidize materials and to remove impurities from the materials using an oxygen ambient gas, but the use of an oxygen ambient may promote the growth of silicon dioxide or other "lower-k" dielectrics at the interface of the gate dielectric layer and the substrate, where silicon dioxide or other lower-k dielectrics reduce the effective capacitance and increase the equivalent oxide-thickness of high-k gate dielectric layers since the effective dielectric constant of the gate dielectric layer is reduced due to the introduction of a lower-k material between the gate dielectric layer and substrate. Thus, the Rotonadaro references are directed to methods which do not include annealing with either an inert ambient gas or an oxygen ambient gas, in direct contrast to the hydrogen-based and oxygen-based annealing steps recited in claim 24. Consequently, the Rotonadaro references each clearly teach away from claim 24.

Since it is well recognized that teaching away from the claimed invention is a *per se* demonstration of lack of *prima facie* obviousness, it is clear that the Examiner has not borne the initial burden of factually supporting any *prima facie* conclusion of obviousness.



Thus, for this reason alone, the Examiner's burden of factually supporting a *prima facie* case of obviousness cannot be met with respect to claim 24. Accordingly, because claims 25-34 and 36-40 depend from claim 24, the rejection of claims 25-34 and 36-40 under 35 U.S.C. §103 should be withdrawn.

**3. The combination of references is improper**

Assuming, arguendo, that none of the above arguments for non-obviousness apply (which is clearly not the case based on the above), there is still another mutually exclusive and compelling reason why Colombo, Ahn, Rotonadaro '826, Rotonadaro '121 and Pomarede cannot be applied to reject claims depending from claim 24 under 35 U.S.C. §103. That is, neither Colombo, Ahn, Rotonadaro '826, Rotonadaro '121 nor Pomarede teaches, or even suggests, the desirability of the combination since none of the references teach the steps of performing a hydrogen-based anneal and an oxygen-based anneal on a high-k material, wherein the hydrogen-based and oxygen-based anneals occur sequentially, among other elements of claim 24.

Thus, it is clear that neither Colombo, Ahn, Rotonadaro '826, Rotonadaro '121 nor Pomarede provides any incentive or motivation supporting the desirability of the combination. Therefore, there is simply no basis in the art for combining the references to support a 35 U.S.C. §103 rejection.

In this context, the courts have repeatedly held that obviousness cannot be established by combining the teachings of the prior art to produce the claimed invention, absent some teaching, suggestion or incentive supporting the combination. In the present case, it is clear that the Examiner's combination arises solely from hindsight based on the invention, since there is no showing, suggestion, incentive or motivation in either reference for the combination as applied to claim 24. Thus, for this reason alone, the Examiner's burden of factually supporting a *prima facie* case of obviousness cannot be met with respect to claim 24. Accordingly, because claims 25-34 and 36-40 depend from claim 24, the rejection of claims 25-34 and 36-40 under 35 U.S.C. §103 should be withdrawn.

**Rejections Under 35 U.S.C. §103: Colombo, Ahn, Rotonadaro '826, Rotonadaro '121 and Rayssac**

Claims 12 and 41 were rejected under 35 U.S.C. §103(a) as being unpatentable over Colombo in view of Ahn, Rotonadaro '826, Rotonadaro '121 and Rayssac. Applicants traverse this rejection on the grounds that the combination of Colombo, Ahn, Rotonadaro '826, Rotonadaro '121 and Rayssac is defective in establishing a *prima facie* case of obviousness for the following mutually exclusive reasons.

**Claim 1**

Applicants traverse the §103 rejection of claim 12 on the grounds that the combination of Colombo, Ahn, Rotonadaro '826, Rotonadaro '121 and Rayssac is defective in establishing a *prima facie* case of obviousness with respect to claim 1 and its dependent claims, for the following mutually exclusive reasons.

**1. Even when combined, the references do not teach the claimed subject matter**

As described above, when evaluating a claim for determining obviousness, all limitations of the claim must be evaluated. However, none of the cited references teach the steps of performing a hydrogen-based anneal and an oxygen-based anneal on a high-k material, wherein the hydrogen-based and oxygen-based anneals occur sequentially, among other elements of claim 1. In fact, none of the references teach performing both a hydrogen-based anneal and an oxygen-based anneal on a high-k material, whether sequentially or otherwise.

For example, the Examiner concedes that Colombo fails to teach performing a hydrogen-based anneal on a high-k material. (Examiner's Office Action, page 8). Further, Ahn fails to teach performing any annealing process on a high-k material, and instead merely mentions that a substrate can be pre-cleaned to minimize surface oxide with an HF clean and/or hydrogen anneal step. (Paragraph [0024]).

Moreover, both Rotonadaro '826 and Rotonadaro '121 teach employing an "H<sub>2</sub> + O<sub>2</sub>" annealing ambient ("wet oxidation") to achieve a relative increase in the advantages of annealing (proper oxidation, purification, and densification) as compared to the disadvantage of annealing (the growth of lower-k dielectrics). However, the Rotonadaro references each teach performing a single annealing step utilizing an annealing ambient comprising hydrogen *and* oxygen, but fail to teach performing a hydrogen-based annealing step and an oxygen-based annealing step.

Additionally, Rayssac fails to teach performing any annealing step on a high-k material, whatsoever. Consequently, Rayssac necessarily fails to teach performing both a hydrogen-based anneal and an oxygen-based anneal.

Thus, each of Colombo, Ahn, Rotonadaro '826, Rotonadaro '121 and Rayssac fail to teach all limitations of claim 1. Consequently, it is impossible for the combination of Colombo, Ahn, Rotonadaro '826, Rotonadaro '121 and Rayssac to render obvious the subject matter of claim 1 as a whole, and the explicit terms of the statute cannot be met.

Thus, for this mutually exclusive reason, the Examiner's burden of factually supporting a *prima facie* case of obviousness cannot be met with respect to claim 1. Accordingly, because claim 12 depends from claim 1, the rejection of claim 12 under 35 U.S.C. §103 should be withdrawn.

**2. Prior art that teaches away from the claimed invention cannot be used to establish obviousness**

In the present case, the Ahn reference, by providing methods for eliminating the cleaning and other silicon dioxide removal steps, is directed to methods which do not include cleaning a substrate surface prior to forming a thin insulate thereon, as recited in claim 1. Thus, Ahn clearly teaches away from claim 1.

Additionally, the Rotonadaro references each teach that rapid thermal processing ("RTP") has been used for gate dielectric layer densification using an inert ambient gas, but the use of such an inert ambient does not properly oxidize the annealed material. The Rotonadaro references also teach that, alternatively, RTP has been used to oxidize materials and to remove

impurities from the materials using an oxygen ambient gas, but the use of an oxygen ambient may promote the growth of silicon dioxide or other “lower-k” dielectrics at the interface of the gate dielectric layer and the substrate, where silicon dioxide or other lower-k dielectrics reduce the effective capacitance and increase the equivalent oxide-thickness of high-k gate dielectric layers since the effective dielectric constant of the gate dielectric layer is reduced due to the introduction of a lower-k material between the gate dielectric layer and substrate. Thus, the Rotonadaro references are directed to methods which do not include annealing with either an inert ambient gas or an oxygen ambient gas, in direct contrast to the hydrogen-based and oxygen-based annealing steps recited in claim 1. Consequently, the Rotonadaro references each clearly teach away from claim 1.

Since it is well recognized that teaching away from the claimed invention is a *per se* demonstration of lack of *prima facie* obviousness, it is clear that the Examiner has not borne the initial burden of factually supporting any *prima facie* conclusion of obviousness.

Thus, for this reason alone, the Examiner’s burden of factually supporting a *prima facie* case of obviousness cannot be met with respect to claim 1. Accordingly, because claim 12 depends from claim 1, the rejection of claim 12 under 35 U.S.C. §103 should be withdrawn.

### **3. The combination of references is improper**

Assuming, *arguendo*, that none of the above arguments for non-obviousness apply (which is clearly not the case based on the above), there is still another mutually exclusive and compelling reason why Colombo, Ahn, Rotonadaro ‘826, Rotonadaro ‘121 and Rayssac cannot be applied to reject claims depending from claim 1 under 35 U.S.C. §103. That is, neither Colombo, Ahn, Rotonadaro ‘826, Rotonadaro ‘121 nor Rayssac teaches, or even suggests, the desirability of the combination since none of the references teach the steps of performing a hydrogen-based anneal and an oxygen-based anneal on a high-k material, wherein the hydrogen-based and oxygen-based anneals occur sequentially, among other elements of claim 1.

Thus, it is clear that neither Colombo, Ahn, Rotonadaro '826, Rotonadaro '121 nor Rayssac provides any incentive or motivation supporting the desirability of the combination. Therefore, there is simply no basis in the art for combining the references to support a 35 U.S.C. §103 rejection.

In this context, the courts have repeatedly held that obviousness cannot be established by combining the teachings of the prior art to produce the claimed invention, absent some teaching, suggestion or incentive supporting the combination. In the present case, it is clear that the Examiner's combination arises solely from hindsight based on the invention, since there is no showing, suggestion, incentive or motivation in either reference for the combination as applied to claim 1. Thus, for this reason alone, the Examiner's burden of factually supporting a *prima facie* case of obviousness cannot be met with respect to claim 1. Accordingly, because claim 12 depends from claim 1, the rejection of claim 12 under 35 U.S.C. §103 should be withdrawn.

#### Claim 24

Applicants traverse the §103 rejection of claim 41 on the grounds that the combination of Colombo, Ahn, Rotonadaro '826, Rotonadaro '121 and Rayssac is defective in establishing a *prima facie* case of obviousness with respect to claim 24 and its dependent claims, for the following mutually exclusive reasons.

#### **1. Even when combined, the references do not teach the claimed subject matter**

As described above, when evaluating a claim for determining obviousness, all limitations of the claim must be evaluated. However, none of the cited references teach the steps of performing a hydrogen-based anneal and an oxygen-based anneal on a high-k material, wherein the hydrogen-based and oxygen-based anneals occur sequentially, among other elements of claim 24. In fact, none of the references teach performing both a hydrogen-based anneal and an oxygen-based anneal on a high-k material, whether sequentially or otherwise.

For example, the Examiner concedes that Colombo fails to teach performing a hydrogen-based anneal on a high-k material. (Examiner's Office Action, page 8). Further, Ahn fails to teach performing any annealing process on a high-k material, and instead merely mentions that a substrate can be pre-cleaned to minimize surface oxide with an HF clean and/or hydrogen anneal step. (Paragraph [0024]).

Moreover, both Rotonadaro '826 and Rotonadaro '121 teach employing an " $H_2 + O_2$ " annealing ambient ("wet oxidation") to achieve a relative increase in the advantages of annealing (proper oxidation, purification, and densification) as compared to the disadvantage of annealing (the growth of lower-k dielectrics). However, the Rotonadaro references each teach performing a single annealing step utilizing an annealing ambient comprising hydrogen *and* oxygen, but fail to teach performing a hydrogen-based annealing step and an oxygen-based annealing step.

Additionally, Rayssac fails to teach performing any annealing step on a high-k material, whatsoever. Consequently, Rayssac necessarily fails to teach performing both a hydrogen-based anneal and an oxygen-based anneal.

Thus, each of Colombo, Ahn, Rotonadaro '826, Rotonadaro '121 and Rayssac fail to teach all limitations of claim 24. Consequently, it is impossible for the combination of Colombo, Ahn, Rotonadaro '826, Rotonadaro '121 and Rayssac to render obvious the subject matter of claim 24 as a whole, and the explicit terms of the statute cannot be met.

Thus, for this mutually exclusive reason, the Examiner's burden of factually supporting a *prima facie* case of obviousness cannot be met with respect to claim 24. Accordingly, because claim 41 depends from claim 24, the rejection of claim 41 under 35 U.S.C. §103 should be withdrawn.

**2. Prior art that teaches away from the claimed invention cannot be used to establish obviousness**

In the present case, the Ahn reference, by providing methods for eliminating the cleaning and other silicon dioxide removal steps, is directed to methods which do not include cleaning a substrate surface prior to forming a thin insulate thereon, as recited in claim 24. Thus, Ahn clearly teaches away from claim 24.

Additionally, the Rotonadaro references each teach that rapid thermal processing (“RTP”) has been used for gate dielectric layer densification using an inert ambient gas, but the use of such an inert ambient does not properly oxidize the annealed material. The Rotonadaro references also teach that, alternatively, RTP has been used to oxidize materials and to remove impurities from the materials using an oxygen ambient gas, but the use of an oxygen ambient may promote the growth of silicon dioxide or other “lower-k” dielectrics at the interface of the gate dielectric layer and the substrate, where silicon dioxide or other lower-k dielectrics reduce the effective capacitance and increase the equivalent oxide-thickness of high-k gate dielectric layers since the effective dielectric constant of the gate dielectric layer is reduced due to the introduction of a lower-k material between the gate dielectric layer and substrate. Thus, the Rotonadaro references are directed to methods which do not include annealing with either an inert ambient gas or an oxygen ambient gas, in direct contrast to the hydrogen-based and oxygen-based annealing steps recited in claim 24. Consequently, the Rotonadaro references each clearly teach away from claim 24.

Since it is well recognized that teaching away from the claimed invention is a *per se* demonstration of lack of *prima facie* obviousness, it is clear that the Examiner has not borne the initial burden of factually supporting any *prima facie* conclusion of obviousness.

Thus, for this reason alone, the Examiner’s burden of factually supporting a *prima facie* case of obviousness cannot be met with respect to claim 24. Accordingly, because claim 41 depends from claim 24, the rejection of claim 41 under 35 U.S.C. §103 should be withdrawn.

**3. The combination of references is improper**

Assuming, *arguendo*, that none of the above arguments for non-obviousness apply (which is clearly not the case based on the above), there is still another mutually exclusive and compelling reason why Colombo, Ahn, Rotonadaro '826, Rotonadaro '121 and Rayssac cannot be applied to reject claims depending from claim 24 under 35 U.S.C. §103. That is, neither Colombo, Ahn, Rotonadaro '826, Rotonadaro '121 nor Rayssac teaches, or even suggests, the desirability of the combination since none of the references teach the steps of performing a hydrogen-based anneal and an oxygen-based anneal on a high-k material, wherein the hydrogen-based and oxygen-based anneals occur sequentially, among other elements of claim 24.

Thus, it is clear that neither Colombo, Ahn, Rotonadaro '826, Rotonadaro '121 nor Rayssac provides any incentive or motivation supporting the desirability of the combination. Therefore, there is simply no basis in the art for combining the references to support a 35 U.S.C. §103 rejection.

In this context, the courts have repeatedly held that obviousness cannot be established by combining the teachings of the prior art to produce the claimed invention, absent some teaching, suggestion or incentive supporting the combination. In the present case, it is clear that the Examiner's combination arises solely from hindsight based on the invention, since there is no showing, suggestion, incentive or motivation in either reference for the combination as applied to claim 24. Thus, for this reason alone, the Examiner's burden of factually supporting a *prima facie* case of obviousness cannot be met with respect to claim 24. Accordingly, because claim 41 depends from claim 24, the rejection of claim 41 under 35 U.S.C. §103 should be withdrawn.



**Conclusion**

It is clear from all of the foregoing that independent claims 1, 13, 24 and 42 are in condition for allowance. Dependent claims 2-12, 14-23, 25-41 and 43-55 depend from and further limit independent claims 1, 13, 24 and 42 and, therefore, are allowable as well.

An early formal notice of allowance of claims 1-55 requested.

Respectfully submitted,



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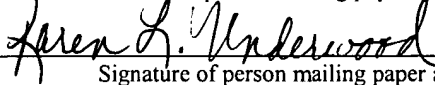
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